LIGHTING DATA

EDISON LAMP WORKS
OF GENERAL ELECTRIC COMPANY

GENERAL SALES OFFICE HARRISON, N. J.

The Lighting of Piers and Warehouses

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Synopsis:

For information regarding Mazda lamps and lighting questions, refer to the nearest sales office.

To insure receipt of bulletins, notify the Department of Publicity, Edison Lamp Works of General Electric Company, Harrison, N. J., of any change of address.

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Reasons for Adequate Lighting

The reconstruction period is requiring great quantities of manufactured products.

How can industry proceed if, with the plants producing huge outputs, the products cannot be moved to the places where required? The factor of transportation is of parallel importance to output.

It can easily be shown and has been demonstrated, to our sorrow, that a weakening of this important link in our system seriously impairs the entire industrial organization. If, for one

FIG. 1

Night View of the Delivery Platform of a Large Railway Pier. This is illuminated by 200-watt bowl frosted MAZDA C lamps with dome enamel steel reflectors hung well out of reach. These are spaced so that slightly over ⅓ watt per square foot is provided. Certainly trucking and freight handling can be carried on with expediency under such illumination

reason or another a terminal becomes congested, this is reflected along the whole line back to the producer. Embargoes are put on and the manufacturers are forced to let up on their output. Each plant depends on others for parts and raw materials. It is, therefore, evident that anything which will help our transportation problem is a factor in our industrial program.

Adequate lighting facilitates the movement of material and proper illumination of warehouses and piers thus indirectly increases and expedites production.

Speeding of shipment by good lighting is increased through the following direct causes:

(*a*) Greater actual speed of trucking, etc.

(*b*) Markings more easily read.

The indirect effects are:

(*c*) Less mis-sent shipments.

(*d*) Reduction of spoilage and thefts.

(*e*) Improved relations with the public.

These are not theoretical statements, but are borne out in practice.

(*A*) If a pier or warehouse is dimly lighted, many portions in deep shadow, truckers must proceed cautiously, watching out for objects lying about on the floor, for they lack the confidence which comes with clear vision. Accident reports reveal that one of the most common causes is stumbling or falling. With poor lighting this hazard is increased. Not only does an accident affect the injured worker, but it has a demoralizing effect on the entire force. Each workman becomes over-cautious and slows down his movements. Proper light, therefore, increases the speed of freight handling.

(*B*) In sorting packages or stowing them aboard ship, it is, of course, necessary to read and check the labels or markings. It is self-evident that with plenty of light, less time will be spent on this step of the handling. In many buildings there are only a few spots where there is enough illumination to read labels, and material actually has to be moved there to be sorted. Certainly this extra handling is not efficient.

(*C*) Conversation with transportation officials indicates that one of their serious troubles is mis-sent shipments. Inadequate illumination is an important contributing cause. The reading matter on way bills is often faint or blurred and many packages are badly addressed. The chances for error under poor light are great. Packages sent to the wrong place sometimes never return. Perishable freight is often entirely lost if mis-sent. Occasionally an entire factory is held up awaiting the arrival of goods, the delay in transportation being due to a mis-sent shipment. Beyond the delay and cost of locating mis-sent material, there follows a further load on the transportation system of sending it to proper destination.

(*D*) Spoilage of goods is reduced if there are no dark corners in which packages of perishable material become hidden. Again,

boxes that have been broken in shipment are readily caught and taken care of before a greater loss is sustained. Breakage is bound to be reduced, for employees will not throw articles about promiscuously if the place is well enough lighted so that they are likely to be seen. Theft is greatly reduced, as the sneak thief would not dare to pry open a bundle and remove part of the goods if the chances of detection were high.

(*E*) Modern business methods have made it important to please the public. Common carriers desire to have the most cordial

FIG. 2

Night View of a Coastwise Steamship Pier Illuminated by 500-watt MAZDA C Lamps in Dome Enamel Steel Reflectors Hung Close to the Roof Trusses. Slightly over ¼ watt per square foot thus furnishes adequate illumination for safety and efficient freight handling

relation with shippers. If consignments are delivered promptly in undamaged condition, if the mis-sent shipments are eliminated, then the transportation agents should have the good will of the people.

Investigation has been made of a considerable number of buildings of the class under consideration and this reveals that in general, the standards of illumination are far too low for the most economic operation. Not only is insufficient light furnished, but in a great majority of cases antiquated equipment is employed. Obsolete types of incandescent lamps, inefficient carbon arc lamps and open

flame gas burners are more prevalent than in almost any other field the authors have investigated. Even where efficient lamps are employed, frequently light is wasted through the absence of proper reflectors. In many cases where reflectors are installed, they have not been well maintained, becoming very dirty, rusted and in some cases, actually falling apart. Bulletin Index 14 contains considerable data on this important question. Incandescent lamps are allowed to burn after becoming badly blackened and gas mantles which have half broken off are still in service.

It is apparent that the effect of light-colored surroundings in increasing the illumination is not fully realized. Ceilings and walls have been allowed to become almost black, reflecting practically no light. A little white paint will save a great deal on the lighting bill and allow increased utilization of daylight. See Bulletin Index 15.

In an investigation of 58 large steamship piers in New York City as regards the artificial lighting, data was obtained on the size of the pier, number and size of lighting units, spacing and height of lamps, height of ceiling, color of walls and ceilings, class of traffic, watts per square foot and general artificial lighting conditions.

The investigators were experienced illuminating engineers, competent to evaluate the resultant illumination. An analysis of the results showed that 6.2 per cent had good illumination, 51.2 per cent fair illumination and 42.6 per cent illumination which was entirely inadequate and generally poor. The average watts per square foot of those piers electrically lighted was 0.16 with a maximum of 0.34 and a minimum of 0.05. Very much better illumination results would have been obtained in practically all the cases if the equipment had been well maintained and surroundings given an occasional coat of whitewash or other light paint. Three and six-tenths per cent of the piers had white walls and ceilings, 9.1 per cent, light colored; 20 per cent, medium colored; 52.8 per cent, dark, and 14.5 per cent very dark (almost black) surroundings.

The above data justifies the foregoing criticism. Such conditions would not be tolerated for the handling of materials in ordinary manufacturing plants, and the surprising feature is that it has been possible to get along at all with such poor light.

In general, the spacing was far too wide for the hanging height of lamp and uneven illumination resulted.

General Requirements of Lighting

Enough light must be provided to read markings, labels and way bills without eye strain, and to see one's way about the entire area.

If the first requirements are provided for, the safety element would naturally be taken care of. A *minimum* of ½ foot-candle seems desirable in all parts of the pier or warehouse. With this intensity average print can be read for a short period with reasonable ease. The Illuminating Engineering Society's Code of Lighting for Factories, Mills and Other Work Places, which has been adopted as mandatory in a number of states, provides a minimum intensity of ¼ foot-candle for passageways, aisles, storage spaces, etc. This value takes care of the safety element alone and is not intended to represent the most economical intensity, the code itself recommending that a higher intensity be provided.

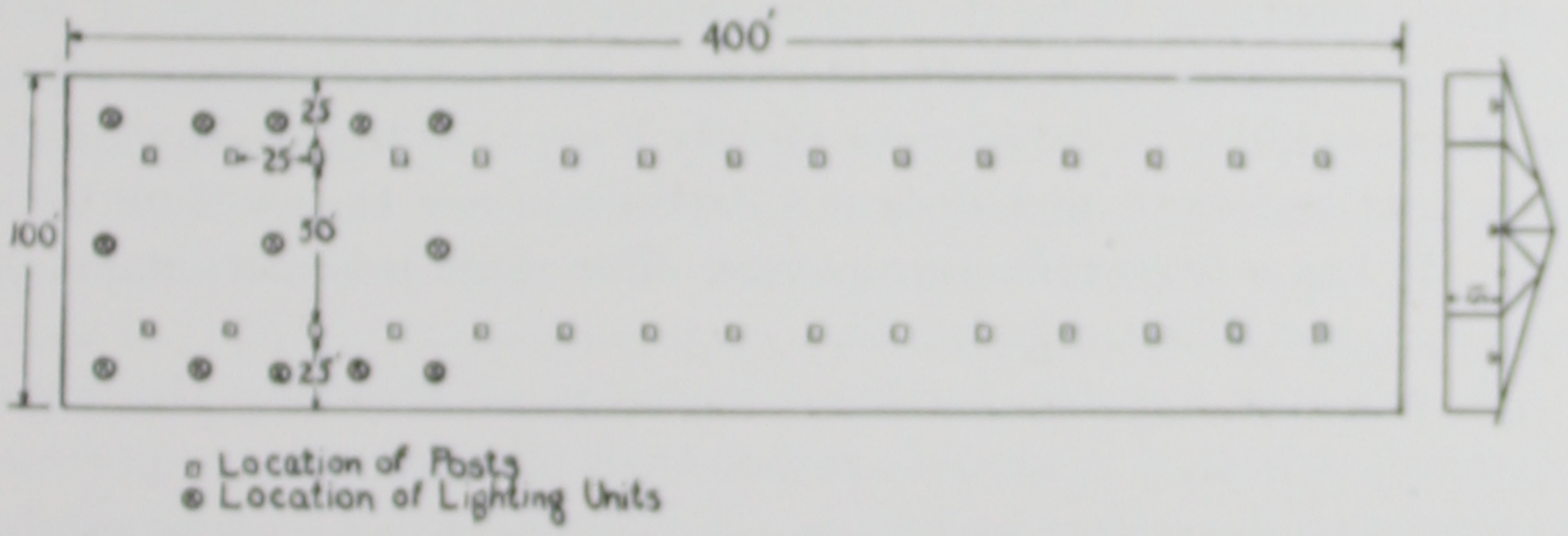

FIG. 3

Typical Arrangement of a Wide Pier with Central Trucking Area and Side Loading Bays Showing Position of Lighting Outlets for Effective Results

In most instances lamps should be hung as high as possible. Properly applied, this does not reduce the average intensity of illumination, in spite of the popular misconception to the contrary. Lamps well up toward the ceiling are not so likely to be broken. In this position they are handled less and reflectors do not become so dirty. Light sources hung low or in the line of view may blind one temporarily and cause him to stumble.

All light sources of an efficient type are too bright to be viewed for any length of time. They require an accessory in the form of a diffusing globe or reflector, which together with proper placement, protects the eyes. In the class of building under consideration it is generally the best practice to utilize open reflectors, in order to get the maximum illumination with the minimum expenditure

of energy. The element of decoration or artistic appearance, beyond neatness, is, of course, not an important feature.

In general, glass reflectors are not well suited for this type of interior on account of the likelihood of their being broken. Freight handlers are none too gentle in their methods and in carrying high pieces, lengths of pipes, etc., no particular pains will be taken to clear the reflectors. An efficient steel reflector is generally the solution.

The RLM standard dome type reflector gives a greater spread of light than the deep bowl, permitting wide spacing without intervening areas in darkness. This style also gives a higher output.

The dirty surroundings have been mentioned before and the surface of the reflector should be such that it can be easily cleaned. Porcelain enamel is virtually a layer of glass applied to the steel base and has all the advantages of glass. It is easy to clean; soap and water or even a wet rag will give the porcelain a bright, clean surface, returning it to its original efficiency, even though it has become greasy or very dirty. It resists acid fumes, whereas other finishes are likely to deteriorate rapidly if exposed to certain vapors. It is heat resistant, and does not depreciate nor turn yellow with age. It has a high reflecting power. For more complete data on reflectors see Bulletin Index 22.

A reflector has the further advantage of directing the light efficiently where it is needed, rather than allowing a large portion to escape to the ceiling and walls. A given area can be adequately lighted with from 25 to 50 per cent less power if lamps are equipped with reflectors, rather than used bare.

As pointed out before, it is most desirable to have walls and ceilings light in color. Paint is a wonderful adjunct to the lighting system. Many a poorly lighted room has been made satisfactory by refinishing the interior.

After the system is properly installed, it should not be neglected. It is most necessary to have a careful system of regular maintenance. Any railroad man certainly knows that his roadbed would not be safe if it were not regularly inspected and kept in first-class condition. A pier would soon fall to pieces if the spiles were not renewed when broken or rotted. On the other hand, lighting equipment is allowed to fall to pieces, lamps to become broken, reflectors rusty and very little attention is paid. The output of light is decreased considerably, even with a small layer of dust or dirt, yet many installations are in operation where equipment has been neglected

for years. Certainly the user is receiving but a very, very small percentage of the light he is paying for.

Choice of the Size of Lamp

As a general rule, the larger lamps are more efficient and cost less per unit of illumination than small lamps. The fewer the number of outlets, the less the cost of wiring and maintenance. On the other hand, in designing an installation a consideration of this feature alone may make the lighting practically worthless. For example, an area of 4000 square feet is to be lighted. If ¼ watt per square foot is provided, 1000 watts are needed. For ordinary ceiling heights, one 1000-watt lamp would certainly not be the type to employ.

The size of the lamp is controlled primarily by the ceiling height. In other words, lamps hung 20 feet above the floor on 20-ft. centers give the same results as lamps 10 feet above the floor on 10-ft. centers. All other items being equal, mind this statement, a 400-watt lamp 20 feet high would be as effective as four 100-watt lamps 10 feet high.

Other items to consider are (*a*) Obstructions of various sorts. If material is piled high or if there is much piping, cross beams, etc., it is apparent that dense shadows would be cast by large lamps widely spaced, which could be avoided by using small lamps spaced more closely together. (*b*) Character of ceiling, walls and general surroundings. If these are light in color, reflecting well, then considerable diffuse light is introduced in the illumination. This eliminates shadows and permits wider spacing. (*c*) Size of bay. The total area is usually divided into bays by posts or columns and for good appearance, as well as ease of construction, it is desirable to install outlets symmetrically with respect to the bays. This, of course, has a determining effect on the spacing and hence on the size of lamps. This practice is particularly important in warehouses where material is piled or stored in reference to the arrangement of posts.

Piers

The annual carrying capacity of a vessel depends, to a considerable degree, upon prompt loading and unloading, so that it is good practice to work night and day when it is at dock.

Due to conditions over which man has no control, such as stormy weather, fog, ice floes and accidents, a fleet of ships cannot main-

tain any absolutely definite schedule as a railroad, and these unavoidable losses of time must be made up. A good lighting system must be maintained in order that the work may be performed efficiently during the dark hours. With poor lighting, no matter how good the mechanical equipment may be, the human element cannot work rapidly and the docking time will be lengthened. The general effects of good lighting, as outlined in the opening paragraphs, are, of course, found on the pier, and it will speed up the handling of material.

FIG. 4

Night View of the Passenger Section of a Large Municipal Pier. The pier which is 2340 ft. long is lighted by a total of 236 400-watt MAZDA C lamps in opalescent enclosing globes hung 25 ft. high. These are on centers 40 by 35 feet

It is further necessary to provide adequate light for the custom officers to properly inspect all freight and baggage in the shortest possible time. The amount of material being handled by the shipping concerns at the present time is greater than ever before, making this subject of vital importance. It is reasonable to estimate that at least one third of the work is done after night time.

There are two general classes of ocean and lake piers, the first, those used for both passenger and freight, the second, those used for the handling of freight only. As a rule, the larger piers of the first class are of the double-deck type, passenger section above, while the freight pier is usually only one story in height.

All piers are long, narrow structures, the sides of which consist of doors through which the freight is passed. The center of the main deck is employed as a driveway for trucks and wagons. Since the freight is loaded from the sides of the piers, more light is required here than over the center, a low intensity sufficing for the trucking. The requirements for the sides of the pier correspond largely with those for a warehouse. The stevedores must read the addresses and place the hoisting tackle around the boxes, bales and casks to be loaded. Lamps should be hung high so that they will not interfere with the storage of freight, will not be broken and so that piles of freight will not cast long shadows. It is often advisable, in the case of a relatively low ceiling, to hang lamps between the girders rather than on them. This permits a slightly higher hanging.

For piers handling general freight and merchandise, the rules for spacing and size of lamps given under warehouses apply for the side bays or loading sections; approximately $\frac{1}{4}$ watt per square foot will give adequate lighting. For the trucking area or center bay, larger lamps can be used on wider spacings. A general figure of $\frac{1}{8}$ watt per square foot will prove satisfactory. A typical loading platform or side bay well lighted in accordance with the rules laid down is shown in the night view, Fig. 1.

Where the pier is relatively narrow with no line of demarkation between the loading areas and the general trucking space, as illustrated in Fig. 2, a symmetrical arrangement of outlets over the entire area best meets the conditions. The diagram, Fig. 3, however, shows an arrangement commonly encountered. For these particular dimensions, 150-watt lamps in enameled dome steel reflectors should be used, one each in the side bays, while 300-watt units of the same character on 50-ft. centers furnish adequate light for the central or trucking space.

For piers devoted to the handling of fruit, the lighting requirements are considerably more exacting. A higher intensity is required and more even distribution. Fruit after being unloaded on the pier is generally sold at auction. The commission merchants visit the piers and inspect the fruit. It is quite important that the

true condition of the fruit be shown to the prospective buyer. It is necessary that the color of the fruit is not distorted and a close approximation to white light is desirable for the artificial illumination. A case is on record where commission merchants have refused perfectly good fruit and left it to rot on the hands of the owners, because it appeared green under artificial light, the color composition of which was such as to distort materially the natural appearance. From 0.3 to 0.5 watt per square foot with MAZDA C lamps is desirable for a fruit pier.

FIG. 5

On Account of the Density of Trucking in the Neighborhood of a Pier, the Surrounding Area Should be Well Illuminated. This night view taken down the center of the Commonwealth Fish Pier, Boston, shows the effect of using 750-watt MAZDA C lamps in street lighting fixtures of the Novalux diffusing type. These are supported on brackets attached to the face of the building

On the passenger decks of the pier, somewhat more attention should be given to the appearance of the unit. Most people who travel by boat for business or pleasure, are of a class which are accustomed to the comforts resultant from good illumination. The patronage of this class of people is most desirable in normal times and a well lighted pier is a factor toward this end. With good lighting the inspection of baggage by the custom officers is facili-

tated, which tends to eliminate one of the greatest inconveniences of ocean travel. A well equipped and thoroughly modern passenger deck is pictured in Fig. 4.

The traffic in the neighborhood of a busy pier is quite heavy. To avoid confusion and resultant delay of trucking, the approaches to a busy pier should have somewhat better lighting than normally furnished by the municipal street lamps. Standards are quite out of the question, as they are very likely to be broken by a truck. Brackets suspended from the face of the building provide the logical solution. Standard street lighting equipments of the various types, with their particular advantages, should be used here. The

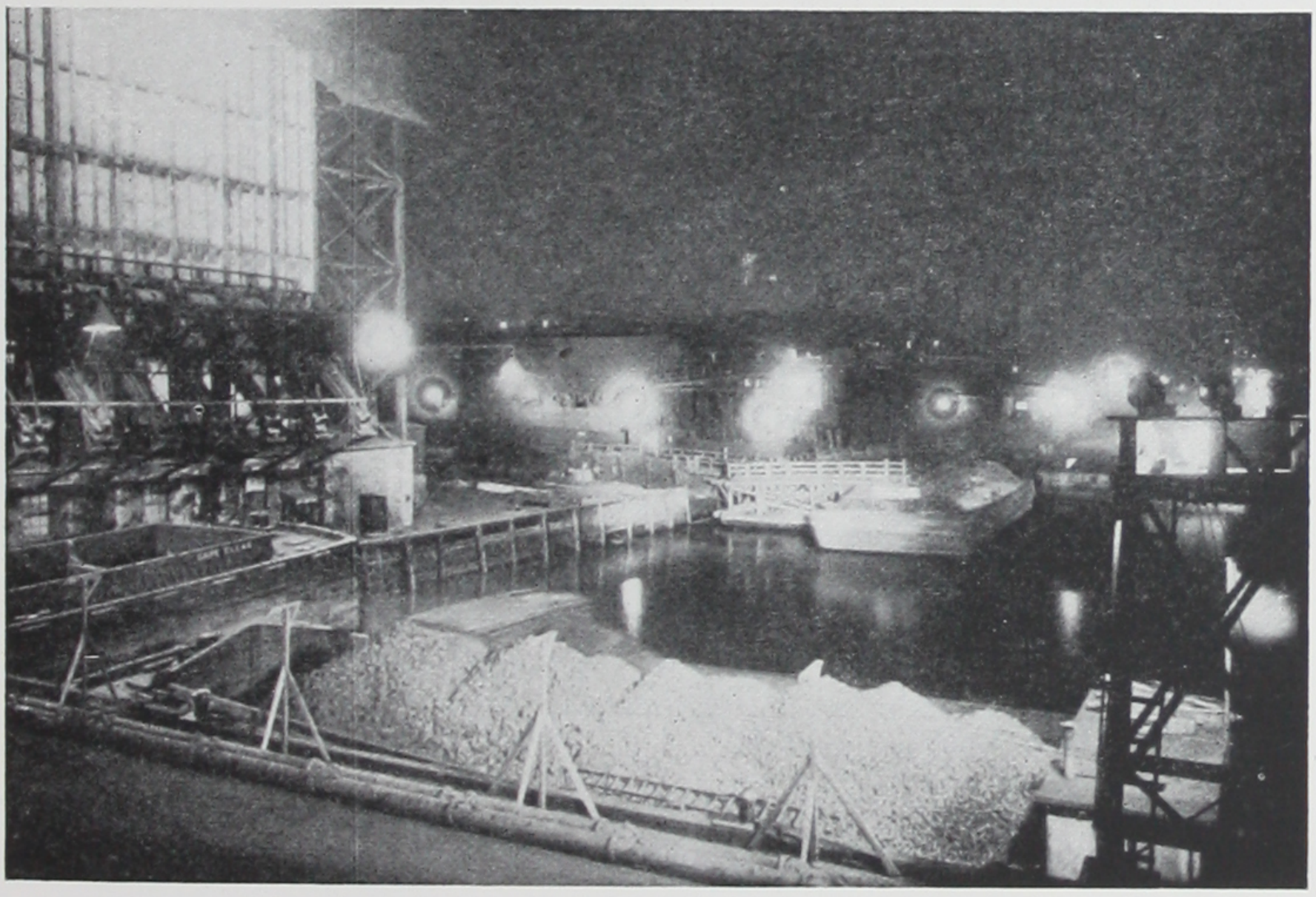

FIG. 6

Night View of the Water Side of a Busy Pier, Lighted by Overhead Units and Flood lighting Projectors. Efficient and safe handling of material is made possible through the liberal use of artificial light

quantity of light or the size and spacing of units is governed largely by local conditions. An excellent example of this form of lighting is shown in Fig. 5.

A completely equipped pier should have high power lamps on the water side of the structure. These should be hung high so that the open hatchways of the ships will be, or can be lighted. This facilitates freight handling and tends to eliminate accident. The actual lighting of the hatchway itself is taken care of by portable lamps, which are part of the ship's equipment.

Goose-neck fixtures mounted on the sides of the piers, often prove unsatisfactory because they are likely to be broken by the ship's booms while loading.

Lighting on the exterior of a pier must be such as will not interfere with the pier signal lights or with navigation in the slips. The loading decks, hatches and pier string pieces must all be lighted. Floodlighting has been app ied for this purpose, but in general, is not the proper method of illumination, for there are numerous obstructions which cast long, dense shadows, making working conditions dangerous. A close approximation to general illumination is desirable.

FIG. 7

Night View of a Well Illuminated Warehouse of Modern Construction. One 200-watt MAZDA C lamp in an enameled dome reflector is placed close to the 15-ft. ceiling in each 20-ft. bay

To light a deck of a ship at an isolated pier, weatherproof, angle type reflectors and high candle-power lamps give a desirable distribution. These should, of course, be hung as high as practicable, and to avoid danger of their being struck and broken, it is well to provide recesses or pockets in the face of the pier.

Where piers are adjoining and two ships are to be lighted at the same time, a somewhat different method may be applied. There is available a special unit of the street lighting type with prismatic band refractor and an exterior globe, mirrored on one half. This equipment gives sufficient light near the pier, and at the same time the broad band of light emitted through the refractor illuminates

the ship at the opposite pier, and cuts shadows. The mirroring prevents waste of light in directions where it is not needed.

It is very essential that equipment used around a pier be weatherproof, as these have to stand up against the attacks of smoke, gas and salt air.

FIG. 8

Day View in a Warehouse Where the Material is Piled Particularly High. The bays are 20 by 20 ft., and each is provided with two outlets. 60-watt MAZDA lamps in deep bowl aluminum finish reflectors are placed close to the 13-ft. ceiling. Lights are controlled in rows by switches, one of which may be seen in the box on the column in the foreground

Warehouses

The light should be quite evenly distributed, as labels and markings must be read anywhere about the floor, yet the demands in this respect are by no means as exacting as where close visual work must be carried on. The intensity should be highest near the doorway and down the main aisles, for here is found the densest traffic. To attain an average intensity of at least 1 foot-candle, and not have the minimum appreciably below ¼ foot-candle, specified in the industrial codes, from 0.15 to 0.25 watt per square foot of floor area is advisable. This figure presumes the use of

high efficiency lamps and suitable reflectors and takes into account an average amount of acquired depreciation, which is rather high in the class of building under consideration.

The following general rules on maxmum desirable spacing apply:

Ceiling 10 feet or less.....16 feet
Ceiling 10 to 15 feet.....20 feet
Ceiling above 15 feet.....30 feet

Of course, these are subject to more or less variation, depending on the manner in which material is stored.

For long, narrow rooms (less than 30 feet or approximately one bay wide) one central row of outlets will serve the purpose well. 75-watt MAZDA C lamps in enameled dome reflectors on 15-ft. centers would be a typical installation for a room with a 10-ft. ceiling, whereas 100-watt units on 20-ft. centers could be used if the ceiling were 15 feet.

If the room is wider, it is well to space outlets symmetrically in the bays. For example, a warehouse from 40 to 60 feet wide should have two rows of lighting units, while one over 60 feet will probably require three rows.

With ceilings averaging 15 feet, one outlet in the center of each 20-ft. standard bay is excellent practice, as shown in Fig. 7. Where material is piled almost to the ceiling, it is necessary to localize units with reference to the aisles, as pictured in Fig. 8.

Bibliography

"Indirect Lighting of a Warehouse,"—*Electrical World*, August 30, 1913.

"The Lighting of Piers and Docks," by A. R. Dennington, *Electrical Age*, February, 1917.

"The Illumination of Railroad Freight Piers," by H. C. Yost, *Railway Electrical Engineer*, May, 1917

"Light as an Aid to the Transportation of Material," by A. L. Powell and R. E Harrington, Trans. I. E. S. Vol. 14, page 1.

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